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EFFECT OF BASE ISOLATION IN MULTISTORIED REINFORCED CONCRETE BUILDING

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ABSTRACT

The concept of isolator in building at base level reduces the possibility of resonance of the structures and increases the time period of the structure giving rise to better seismic performance of the building. The study is performed for comparison the effectiveness of fixed base and base isolated multistoried RC frame building. For the study, two buildings are considered the first structure G+5 storey building and second structure G+17 storey building which is designed and analyzed. The lead rubber bearing (LRB) and friction pendulum system is designed as per UBC97 and ASCE07 code and the same was used for the analysis of base isolation system. The results obtained from the analysis were time period and base shear. Time period for the base isolated structure higher than that of fixed based structure. Base shear is significantly reduced in each direction (X and Y direction) as compared to fixed base building by using the isolators.

Key words: Base isolation, Lead rubber bearing, Friction pendulum system, Response spectrum analysis (RSA), Time history analysis (THA), ETABS2015.

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1. INTRODUCTION

Earthquake causes significant loss of life and severe damage to property mostly to man-made structures. Many researchers established that isolators provide a better performance to seismic design procedure [1]. The isolators works on the procedure that which decouples the superstructure and foundation from ground motion which leads to reduce the earthquake attack on the superstructure [2]. Isolation system does not absorb the earthquake energy it defects through dynamics of the system [3]. The decoupling of the superstructure and foundation is done by increasing the flexibility of the structure together with adding a structure damping [4]. A source of damping is provided to reduce the deflection of the structure [5]. Flexible structures such as high-rise buildings can effectively reduce structural responses and can avoid resonant condition [6]. Seismic isolation systems are more effective when applied to high stiffness, low-rise buildings, owing to their abilities of the building from rigid to flexible[7].Base isolators reduces the resonance of building by increasing the time period of the structure which results in reducing the base shear, increasing the storey displacements.

2. TYPES OF BASE ISOLATORS

The selection of a particular seismic isolation depends up on the whole mass of the structure and effective stiffness of the structure. The types of isolators are classified as follows.

2.1. Laminated Rubber bearings (Elastomeric bearings)

Laminated rubber bearings are constructed of alternating rubber layers bonded to intermediate steel shim plates. The total thickness of rubber provides the horizontal stiffness to achieve the period shift where as the spacing of steel shim plates controls vertical stiffness of the bearing. Laminated rubber bearings are divided into three types.

- Natural Rubber Bearing
- Lead Plug Rubber Bearing
- High-Damping Rubber Bearing

2.1.1. Natural Rubber Bearings

Rubber bearings have two steel endplates and many thin steel shims inter bedded with the rubber as shown in figure1.Steel shims can provide the capability of the vertical stiffness but have no effect on the horizontal stiffness, which is dominated by the shear modulus of the elastomer. The material in shear is quite linear up to shear strains above 100%, with damping in the range of 2-3%, which means that the isolators have exactly linear behavior.

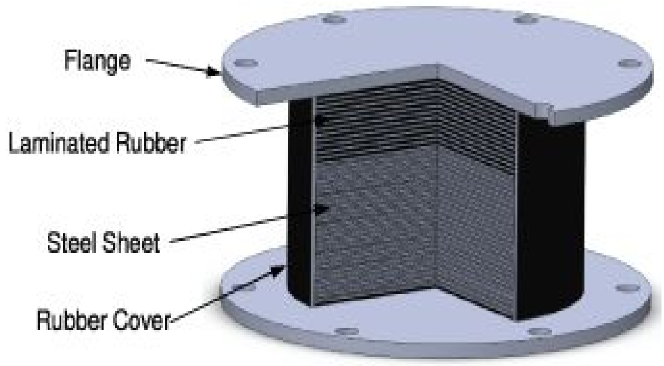

Figure 1 Natural Rubber Bearing

2.1.2. High Damping Rubber (HDR) Bearing

High damping rubber bearing is also same as natural rubber bearing only the difference is the damping ranges from 8%-20%.The shear modulus of high damping elastomeric ranges between 0.34 MPa and 1.40 MPa .The material is nonlinear at shear strains less than 20% and characterized by higher stiffness and damping which minimizes the responses under low level seismic load. Over the range of 20-120% shear strain the shear modulus is low and constant. Natural rubber bearing is shown in Fig1 is same as high damping rubber bearing.

2.1.3. Lead Rubber Bearing (LRB)

LRB consists of three main pieces of equipments, i.e. layers of steel plates, rubber layers and lead core. Same as the steel shims in natural rubber bearings, the layers of steel provides vertical stiffness and the layers of rubber supply the device with high lateral flexibility. Lead core is the device that will supply extra stiffness to the isolators and appropriate damping to the system. LRB bearing is shown in Fig2.

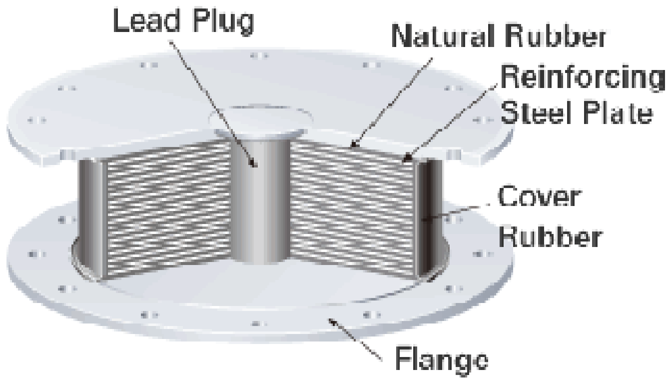

Figure 2 Lead Rubber Bearing

2.2. Friction Pendulum Sliding (FPS) Bearing

The friction pendulum system (FPS) is a widely used bearing based on the principle of sliding system and with a pendulum type isolator to provide a damping function using friction. The FPS isolator has an articulated slider moving on a spherical friction surface coated with a self-lubricating composite material. The FPS isolator is economical compared to elastomeric bearings. The schematic diagram of FPS isolator is shown in fig3.

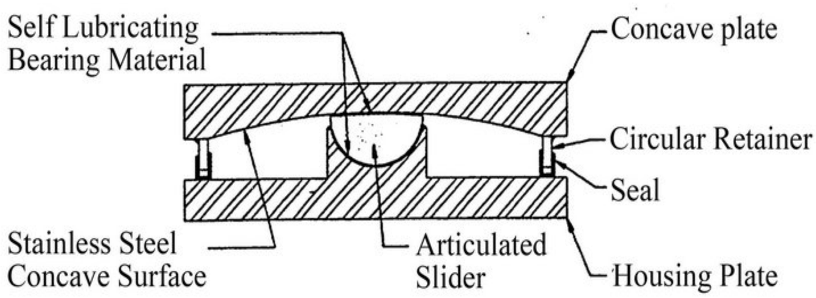

Figure 3 Friction Pendulum Isolator

3. DETAILS OF MODEL

In this paper, the comparison of seismic responses of base isolated structures with fixed base is performed. Two different structures are presented in this study, first structure is low rise building and second is high rise building which are situated in zone-III. Time history analysis is performed by using the data chamoli in Uttar Pradesh of magnitude 4.8.

Model 1: Fixed base building for G+5 storeys
Model 2: Lead rubber isolated building for G+ 5 storeys
Model3: Friction pendulum isolator building for G+ 5 storeys
Model 4: Fixed base building for G+17 storeys
Model 5: Lead rubber isolated building for G+ 17 storeys
Model 6: Friction pendulum isolated building for G+ 17 storeys

The parameters considered for G+5 and G+17 are shown the following tables1,2 and table 3,4 shows isolators properties

Table 1 Building details for G+5

Grade of concrete	**M25**
Grade of steel	Fe500
Storey height	3m
Beam size	230*410mm
Column size	230*450mm
Slab thickness	125mm
Wall thickness	230mm
Parapet height	1m
Live load on the floor	2.5KN/m^2
Live load on the roof	1.25KN/m^2
Zone	3
Importance factor I	1
Building type	SMRF
Soil profile	Medium sites

Table 2 Building details of G+17

Grade of concrete	**M25**
Grade of steel	Fe500
Storey height	3m
Beam size	300*500mm 400*600mm
Column size	400*650mm 400*700mm
Slab thickness	150mm
Wall thickness	230mm
Parapet height	1m
Live load on the floor	3KN/m^2
Live load on the roof	1.5KN/m^2
Zone	3
Importance factor	1
Building type	SMRF
Soil profile	Medium sites

Table 3 Properties of isolators for G+5

Type	LRB	FPS
Vertical stiffness (U1)	808094.40 KN/m	2900000 KN/m
Linear stiffness (U2 &U3)	4698 KN/m	1450 KN/m
Yield Strength (Q)	192.42KN	-
Damping (β)	0.05	0.05
Radius of dish (R)	-	1.01m

Table 4 Properties of isolators for G+17

Type	LRB	FPS
Vertical stiffness (U1)	5588876.20 KN/m	8288395.35 KN/m
Linear stiffness (U2 &U3)	5580KN/m	2850 KN/m
Yield Strength (Q)	205.48KN	-
Damping (β)	0.10	0.10
Radius of dish (R)	-	1.01m

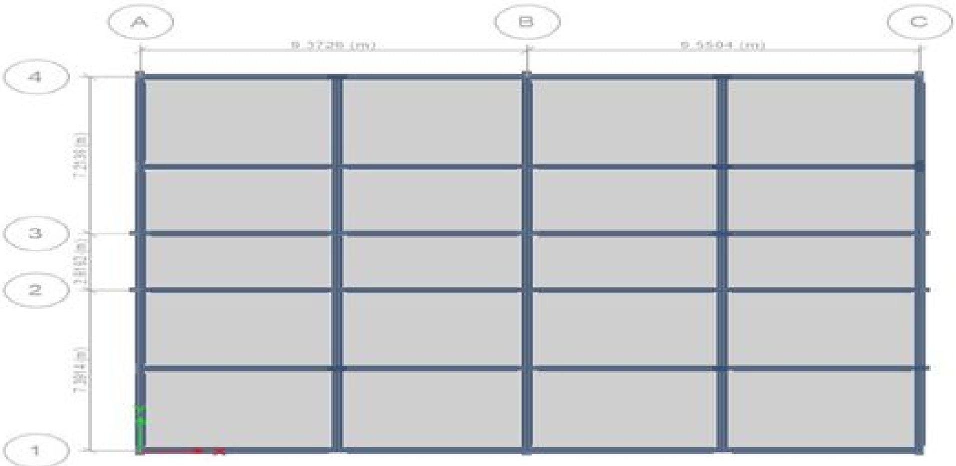

Figure 4 Buliding Plan of G+ 5 Storeys with fixed base

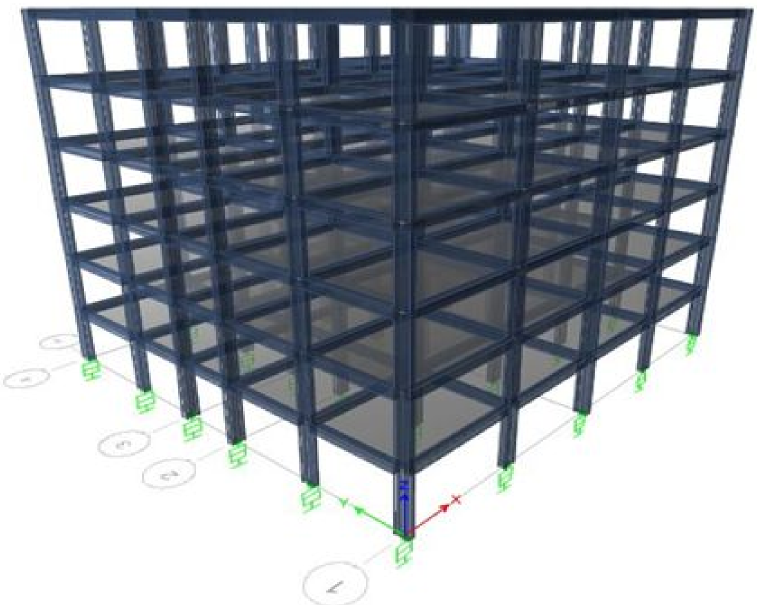

Figure 5 3D View of G+ 5 Base Isolated Structures

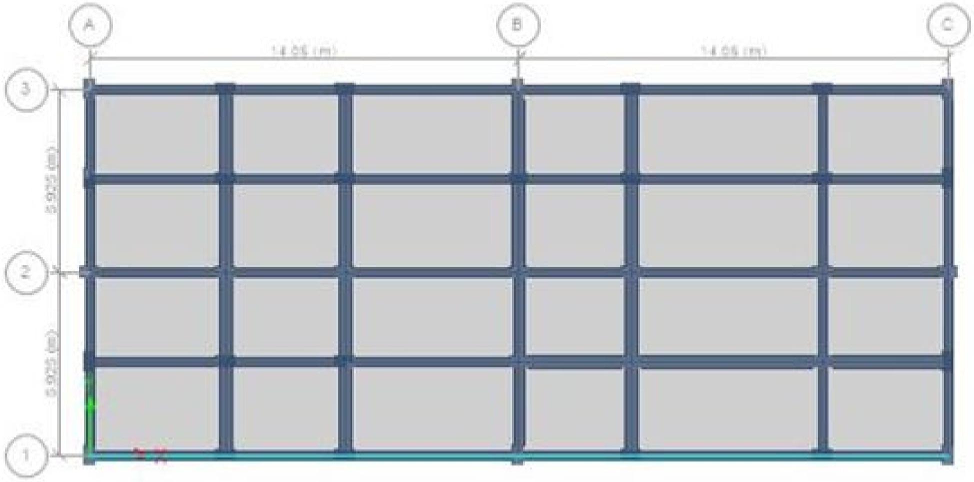

Figure 6 Bulidng Plan of G+17 Storeys with fixed base

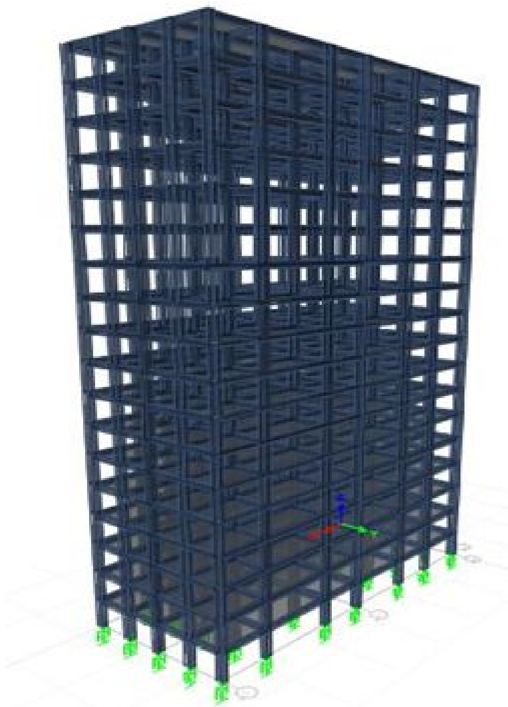

Figure 7 3D View of G+ 17 Storeys with Base Isolated

4. RESULT AND DISCUSSION

4.1. Mode Period

Table 5 Time period of G+5 Storeys

NUMBER	MODE SHAPE	TIME PERIOD(sec.) FIXED BASE	TIME PERIOD(sec.) LRB isolation	TIME PERIOD(sec) FPS isolation
1	Mode	0.934	2.545	2.86

4.2. Base Shear (KN)

SNO	FIXED BASE	LRB	FPS
1	3219(Max)	948	885
2	642(Min)	154	207

4.2.1. Storey Displacement

The graph shows the storey displacement for EQ X

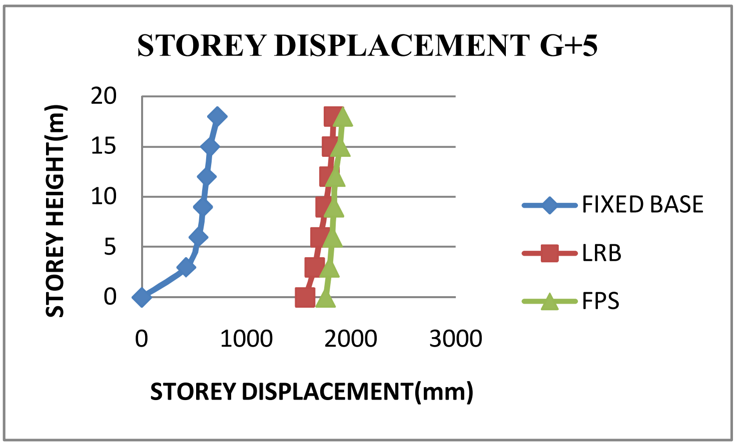

Figure 8 Storey Displacement in X-direction

4.2.2. Storey Drift

The graph shows drift in X-direction for EQ X

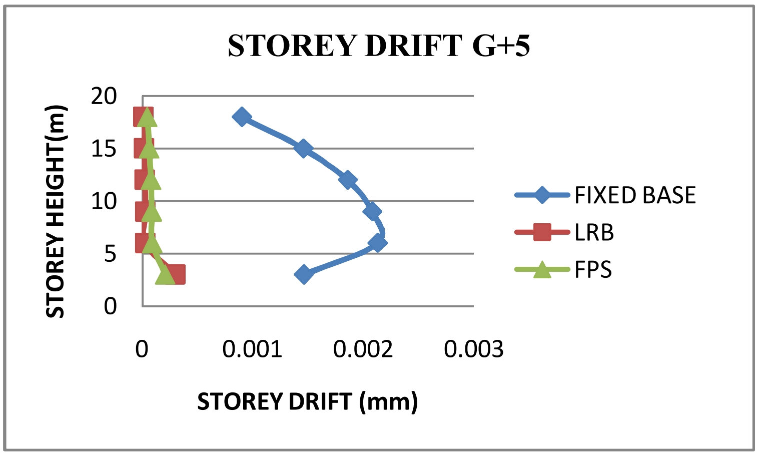

Figure 9 Storey drifts in X-direction

4.2.3. Storey Acceleration

The graph shows the storey acceleration in x-direction for RSA

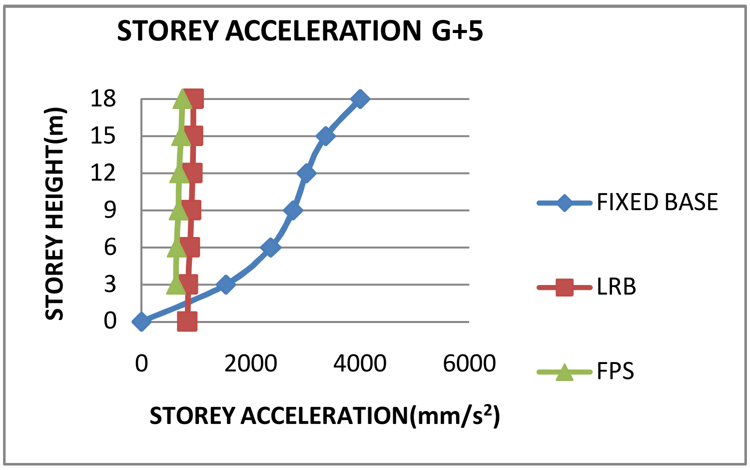

Figure 10 Storey Acceleration in X-direction

4.3. Model Period

Table 6 Time Period of G+17 Building

NUMBER	MODE SHAPE	TIME PERIOD(sec.) FIXED BASE	TIME PERIOD(sec.) LRB isolation	TIME PERIOD(sec) FPS isolation
1	Mode	1.887	3.059	4.05

4.4. Base Shear (KN)

SNO	FIXED BASE	LRB	FPS
1	5389.69(Max)	4809	1801
2	655.559(min)	280.55	251

4.4.1. Storey Displacement

The graph shows the displacement in X-direction for EQ X

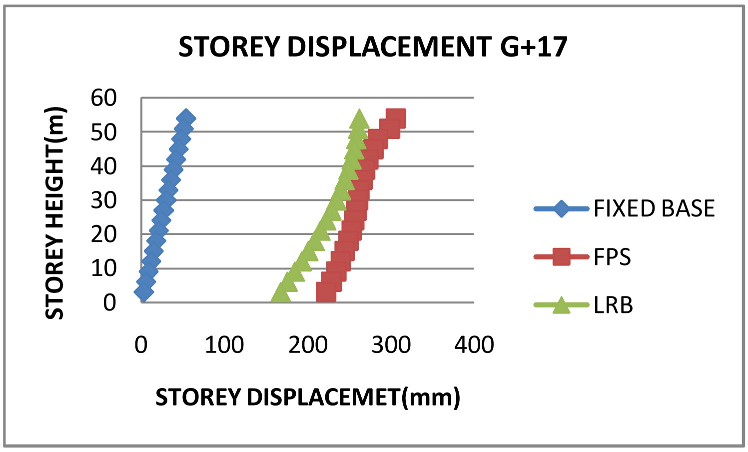

Figure 11 Storey Displacement in X-direction

4.4.2. Storey Acceleration

The graph shows the storey acceleration in X-direction for THA

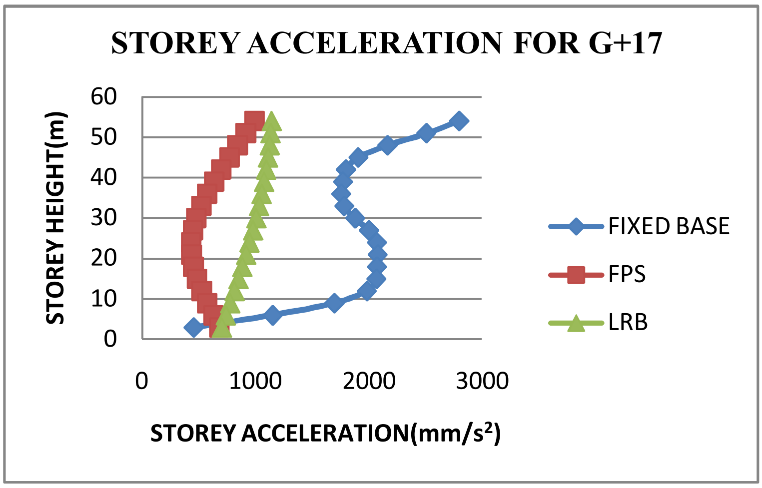

Figure 12 Storey Acceleration in X-direction

4.4.3. Storey Drift

The graph shows the storey displacement in X-direction for EQ X

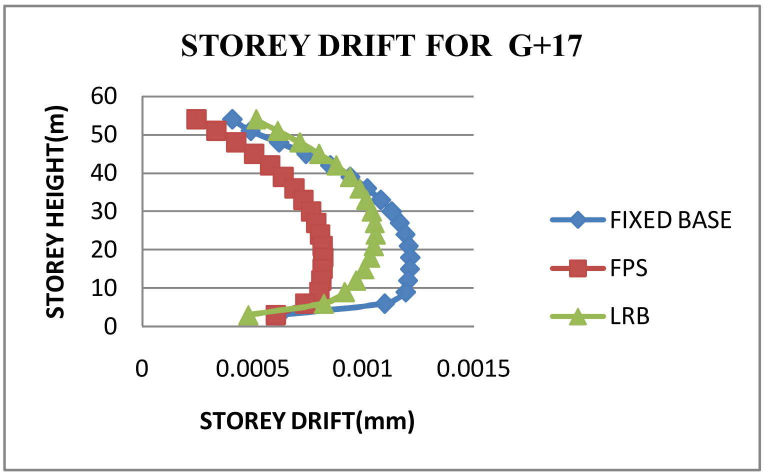

Figure 13 Storey Drift in X-direction

5. CONCLUSIONS

- Base isolation method has proved to be a better method of earthquake resistant design.
- The results shows that the responses of structures can be reduced by the use of lead rubber bearings (LRB) and Friction pendulum systems(FPS) isolators.
- The result of base shear is reduced by the both isolators compared to fixed base structure.
- The time period of both the isolated structures has been increased compared to fixed base structure.
- The storey displacement is increases in both the isolated structures in both directions.
- Results show that the storey drifts is reduced by using the isolators.

- Results shows that storey acceleration considerably reduces by using base isolation devices over the conventional structure.

REFERENCES

[1] Dia Eddin nassani, Mustafa Wassef Abdulmajeed, “Seismic Base isolation in Reinforced concrete structures.”

[2] Chandak N.R, “Effect of Base Isolation on the Response of Reinforced concrete Building.”

[3] T.Nagajyothi, Dr.Vaishali, G.Ghorpade, “Design of Lead rubber bearing system and high damping rubber bearing system for isolated structure for long time periods for a five storey R.C. Buildings.”

[4] Suhail V.M,Syed Ahamed Raza, “Seismic analysis of R.C. Buildings provided with HDRB isolators of various rubber thickness.”

[5] Ashish R.Akhare, Tejas R.Wankhade, “Seismic performance of RC structures using different base isolator.”

[6] Anusha R Reddy, Dr.V Ramesh,“Seismic analysis of Base isolated Building in RC Framed Structures.”

[7] Tai-Chieh Wu,Design of Base isolation system for buildings. M.sc thesis, Chung-Yuan Christian University,Chung-Li,Taiwan 2001.

[8] S.K.Sabu ,H.S.Chore, S.B.Patil, “Effectiveness of Lead rubber Base isolators, for seismic resistance of Buildings, supported on different soil stratas.”

[9] Sarvesh K JAIN, Shashi K THAKKAR, “ Seismic Response of building Base isolators with filled rubber bearings under earthquakes of different characteristics.”

[10] Anil K Chopra,“Dynamics of structures”, Prentice-Hall,1995.

[11] IS 456-2000, IS 1893-2002, IS codes for R.C.C and Earth quake resistant designs respectively.

[12] ASCE-07,UBC-97, Codes are used for design of isolators.

[13] Dr. S. B. Shinde and N.B. Raut, Effect of Change in Thicknesses and Height in Shear Wall on Deflection of Multistoried Buildings. *International Journal of Civil Engineering and Technology*, 7(6), 2016, pp.587–591.

[14] Iswarya G, Vaishali G Ghorpade and Sudarsana Rao H, Seismic Excitation of Low to High Rise RCC Structure with Lead Rubber Bearing Base Isolation. *International Journal of Civil Engineering and Technology*, 7(6), 2016, pp.472–481.